Space Weather Technical Forecast

Issued on Monday, 19 December 2022 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares. Slight Chance of Minor Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional mid-ranking C-class flares observed at GOES16, peaking with a C7.5 at 19/1154UTC, with this event associated with AR3167. Many of the other similar-magnitude flares originated from AR3169 in the northeast. AR3169 also showed the most notable growth tendency over the 24 hours, with significant development in its trailing and intermediate spots. This group now covers a significant span, although it may be better described as a large Zurich Esi followed by still another new sunspot group at a slightly higher solar latitude, although this is difficult to discern given their proximity to the northeastern horizon.

The above were two of up to nine sunspot regions on the Earth-facing disc during the period, although AR3160, recently moved from view to the northwest limb. Growth in other regions was generally more limited, with AR3166 and AR3167 both seeing slow changes in their intermediate spots, while AR3163 became more open as its central spots faded.

There remain numerous filaments on the disc, although none obviously erupted in the 24 hours. There were numerous Coronal Mass Ejections (CMEs) observed on Lasco coronagraphs in the period, all these are considered to be non-Earth directed but the latest one associated with the C-flare from AR3167 in the northwest quadrant is awaiting further analysis for confirmation

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR have remained slow but have gradually increased from 300km/s to 350 km/s. The Density increased from average (5-10 ppcc) to above average for the period 19/0040-0435 UTC, with a peak of 45ppcc at 19/0311 UTC. The total magnetic field was moderate throughout (8-15 nT), with the north south component mainly negative, peaking at -13 nT at 19/0500 UTC. The phi angle was negative (towards the Sun throughout). The wind profile suggest a CIR followed by the negative high speed stream from coronal hole 54, all be it rather slow. There may also have been some CME effects encompassed within. Resultant geomagnetic activity was mainly Quiet to Unsettled (Kp 0-3), but Active (Kp 4) 19/0300-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels.

High energy electron flux (greater than 2 MeV), as observed by GOES16, was at Background to Moderate levels. The associated 24-hour fluence was roughly level and well below Active (1e8 integrated pfu). Observed fluence at 19/0001UTC was 1.99e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is currently Low. There is a chance of increasing to moderate at times due to isolated M-class flares, and a slight chance of an X-class flare. There are currently eight sunspot regions on the disc at present. Successive departures over the western solar horizon through the period may be compensated for by hints of large arriving regions in the east, although this aspect of the forecast is lower confidence, and for now the risk is held constant throughout.

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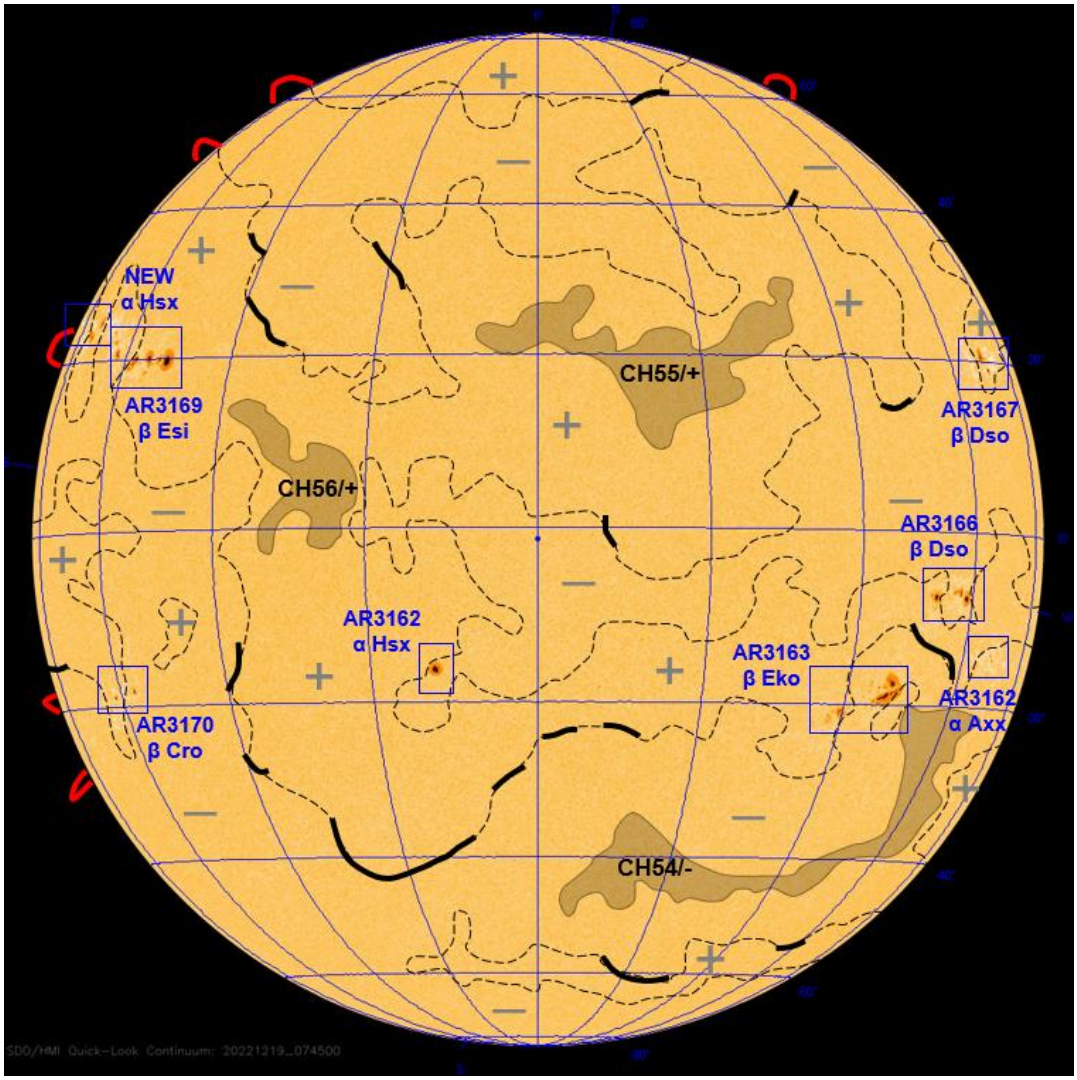
Solar Wind / Geomagnetic Activity: Up to two CMEs from the 15th and 18th December may produce glancing blows at Earth on day 1 (19th) and days 3/4 (21st/22nd) respectively, but are low confidence.
The forecast otherwise comprises of two fast wind streams: firstly the imminent high speed stream from CH54/-, which perhaps offers a Slight Chance of G1 on Monday 19 December. After a lull into Tuesday, a second fast wind from CH55/+ may arrive before midweek to give the peak risk of G1 for the four-day period, albeit still a small risk given our proximity to the solstice.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels throughout, although there is slight chance of S1 level storms with the occurrence of any notable flares.
High energy (greater than 2 MeV) electron flux is currently at Background to Moderate flux, and expected to persist at these levels. The associated 24-hour fluence is expected to continue well below the Active (1e8 integrated pfu) threshold with a mostly flat trend anticipated.

Figure 1. Solar Analysis Valid 19/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

It looks as if Earth has entered the high speed stream of CH54/-, although wind speeds remain rather slow. There is a chance that this enhancement may be furthered during day 1 (19th) due to fringe CME effects. Both these enhancements are likely to wane as we enter day 2 (20th), before the more assured arrival of a second fast wind from CH55/+, with MOSWOC Enlil perhaps indicating speeds of around 500km/s. Because of a more advanced western edge to this hole than on last pass, it may just arrive at the very end of day 2 (20th). Slightly elevated or elevated winds are then expected to continue through the remainder of the period. There is also a slight chance late on day 3 (21st) into day 4 (22nd) of a glancing blow from a second CME which left the Sun on the 18th December nut confidence is low.
Geomagnetic is likely to be mainly Quiet to Unsettled, with a chance of Active intervals, most likely upon the arrival of the fast wind from CH55/+ late on day 2 into day 3 (20th/21st). There is a slight chance of G1 throughout, with the arrival of CH55 the most likely candidate for this.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/1743	Partial	Unknown	NE	790	18th into 19th I	Low confidence
18/1555	Partial	AR3162	SW	455	21st into 22nd	Low confidence

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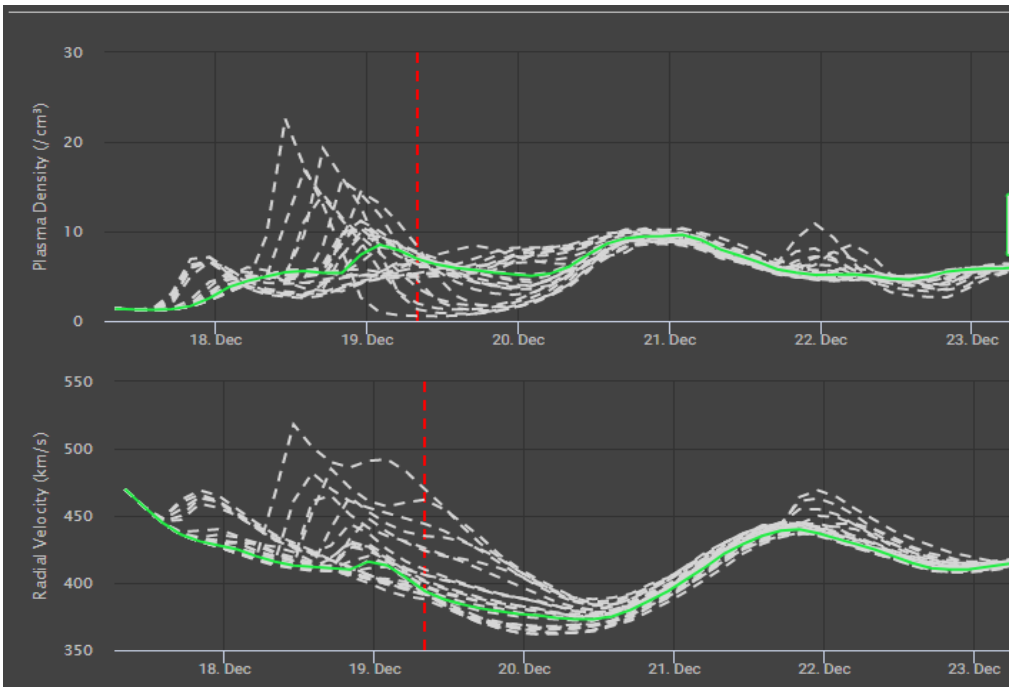
Figure 2: Latest Enlil ensemble with green showing control run. Uncertainty in possible enhancements at the start of the period but more confidence regarding enhancement with CH55/+ 20th/21st.



Radio Blackouts - X-Ray Flares:

There are now eight sunspot regions on the solar disc, with some signs that a higher latitude portion of emerging AR3169 in the northeast may constitute a new spot region. The main changes in the sunspots on the Earth-facing side were seen in AR3169 especially, with areal growth and proliferation in its trailing portion, although this was not capped by significant X-ray activity.
The front-side population of sunspot groups is likely to be in a constant state of flux in the period, with the successive departures of AR3162, AR3166 and AR3167 over the western horizon perhaps countered by new regions arriving over the eastern limb. Of particular interest is a large region suggested by far-side soundings and some halo CMEs in the last working week. This may arrive into the current UTC working week to bolster the recently-reduced risk of significant flares, although any contribution from this has yet to be determined.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	30
Very Active	R3 to R5 X Class	No	5	5	5	5

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) will most likely continue at Background levels, however there is a Slight Chance throughout of a S1+ event. This chance is held slightly higher when compared with the raw disc probabilities at first due to the presence of Ex-AR3165, which remains in a geoeffective location just over the southwestern solar horizon for the time being. There is also the possibility of an increase in probabilities later in the period with recent far-sided CME and flare activity approaching the east limb, but this will be assessed as and when these present for analysis.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	15	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy (greater than 2 MeV) electron flux is following a stable low magnitude diurnal oscillation at present. Whilst CH54 and CH55 may become geoeffective in turn in the period, neither is currently envisaged as being capable of giving Active 24-hour integrated fluence, on a par with previous rotations. Confidence in this is perhaps lower than average, with both of these coronal holes' geometries changed since last pass, as well as the possible complicating presence of up to two CMEs. For its part, MOSWOC REFM suggests current modest electron fluence levels should persist throughout, although this does not allow for any transient activity.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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